

1 **CLAIMS:**

- 2 1. A fuel cell power system comprising:
3 a plurality of fuel cells electrically coupled with plural terminals
4 and individually configured to convert chemical energy into electricity;
5 and
6 a digital control system configured to at least one of control and
7 monitor an operation of the fuel cells.
- 8
- 9 2. The fuel cell power system according to claim 1 wherein the
10 control system is configured to control the operation.
- 11
- 12 3. The fuel cell power system according to claim 1 wherein the
13 control system is configured to monitor the operation.
- 14
- 15 4. The fuel cell power system according to claim 1 wherein the
16 fuel cells are coupled in series.
- 17
- 18 5. The fuel cell power system according to claim 1 wherein the
19 control system comprises a plurality of distributed controllers.
- 20
- 21 6. The fuel cell power system according to claim 5 wherein the
22 distributed controllers are configured in a master\slave relationship.
- 23
- 24

1 7. The fuel cell power system according to claim 1 wherein the
2 fuel cells comprise polymer electrolyte membrane fuel cells.

3

4 8. The fuel cell power system according to claim 1 wherein the
5 fuel cells are configured to be individually selectively deactivated and
6 remaining ones of the fuel cells are configured to provide electricity to
7 the terminals with others of the fuel cells deactivated.

8

9 9. The fuel cell power system according to claim 8 wherein the
10 fuel cells are individually configured to be physically removable.

11

12 10. The fuel cell power system according to claim 8 wherein the
13 fuel cells are individually configured to be electrically bypassed.

14

15 11. The fuel cell power system according to claim 1 further
16 comprising a plurality of switching devices configured to selectively shunt
17 respective fuel cells.

18

19 12. The fuel cell power system according to claim 11 wherein
20 the control system is configured to monitor at least one electrical
21 characteristic of the fuel cells and to control the switching devices
22 responsive to the monitoring.

1 13. The fuel cell power system according to claim 1 further
2 comprising:

3 a housing about the fuel cells;
4 a temperature sensor within the housing; and
5 an air temperature control assembly configured to at least one of
6 increase and decrease the temperature in the housing.

7

8 14. The fuel cell power system according to claim 13 wherein
9 the control system is configured to monitor temperature using the
10 temperature sensor and to control the air temperature control assembly
11 responsive to the monitoring to maintain the temperature within the
12 housing within a predefined range.

13

14 15. The fuel cell power system according to claim 13 wherein
15 the control system is configured to monitor temperature using the
16 temperature sensor and to control the air temperature control assembly
17 responsive to the monitoring to maintain the temperature within the
18 housing within a predefined range of approximately 25 °Celsius
19 to 80 °Celsius.

20

21 27. The fuel cell power system according to claim 1 further
22 comprising a fan configured to direct air to the fuel cells, and the
23 control system is configured to control the fan.

1 17. The fuel cell power system according to claim 1 further
2 comprising a plurality of valves configured to supply fuel to respective
3 fuel cells, and the control system is configured to control the valves.

4

5 18. The fuel cell power system according to claim 1 further
6 comprising a main valve configured to supply fuel to the fuel cells, and
7 the control system is configured to control the main valve.

8

9 19. The fuel cell power system according to claim 1 further
10 comprising a communication port adapted to couple with a remote
11 device, and the control system is configured to communicate with the
12 remote device via the communication port.

13

14 20. The fuel cell power system according to claim 19 wherein
15 the shut down operation deactivates one or more of the fuel cells.

16

17 21. The fuel cell power system according to claim 19 wherein
18 the shut down operation deactivates all the fuel cells.

19

20 22. The fuel cell power system according to claim 1 further
21 comprising a switching device intermediate one of the terminals and the
22 fuel cells, and the control system is configured to control the switching
23 device.

1 23. The fuel cell power system according to claim 1 further
2 comprising:

3 a housing about the fuel cells; and
4 a fuel sensor configured to monitor for the presence of fuel
5 within the housing, and the control system is coupled with the fuel
6 sensor and configured to implement a shut down operation responsive
7 to a detection of fuel within the housing.

8

9 24. The fuel cell power system according to claim 1 wherein the
10 fuel cells are provided in a plurality of cartridges.

11

12 25. A fuel cell power system comprising:
13 a housing;
14 a plurality of terminals;
15 a plurality of fuel cells within the housing and electrically coupled
16 with the terminals and configured to convert chemical energy into
17 electricity;
18 a plurality of valves adapted to couple with a fuel source and
19 configured to selectively supply fuel to respective fuel cells; and
20 a control system configured to control the plurality of valves.

21

22 26. The fuel cell power system according to claim 25 wherein
23 the control system comprises a plurality of distributed controllers.

1 27. The fuel cell power system according to claim 25 wherein
2 the fuel cells comprise polymer electrolyte membrane fuel cells.
3

4 28. The fuel cell power system according to claim 25 wherein
5 the fuel cells are configured to be individually selectively deactivated
6 and remaining ones of the fuel cells are configured to provide electricity
7 to the terminals with others of the fuel cells deactivated.

8

9 29. The fuel cell power system according to claim 28 wherein
10 the fuel cells are individually configured to be physically removable.

11

12 30. The fuel cell power system according to claim 28 wherein
13 the fuel cells are individually configured to be electrically bypassed.

14

15 31. The fuel cell power system according to claim 25 wherein
16 the control system is configured to monitor at least one electrical
17 characteristic of the fuel cells and to control the respective valves
18 responsive to the monitoring.

1 32. A fuel cell power system comprising:

2 a housing;

3 a plurality of terminals;

4 at least one fuel cell within the housing and electrically coupled

5 with the terminals and configured to convert chemical energy into

6 electricity;

7 a bleed valve configured to selectively purge matter from the at

8 least one fuel cell; and

9 a control system configured to control selective positioning of the

10 bleed valve.

11

12 33. The fuel cell power system according to claim 32 wherein

13 the control system comprises a plurality of distributed controllers.

14

15 34. The fuel cell power system according to claim 32 wherein

16 the at least one fuel cell comprises a plurality of polymer electrolyte

17 membrane fuel cells.

18

19 35. The fuel cell power system according to claim 32 wherein

20 the at least one fuel cell comprises a plurality of fuel cells.

1 36. The fuel cell power system according to claim 35 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5

6 37. The fuel cell power system according to claim 32 wherein
7 the control system is configured to periodically open the bleed valve.

8

9 38. The fuel cell power system according to claim 32 further
10 comprising a connection arranged to provide drainage from an anode
11 side of the at least one fuel cell to the bleed valve.

12

13 39. A fuel cell power system comprising:
14 a housing;
15 a plurality of terminals;
16 at least one fuel cell within the housing and electrically coupled
17 with the terminals and configured to convert chemical energy into
18 electricity;
19 a fan within the housing and configured to direct air to the at
20 least one fuel cell; and
21 a control system configured to control an operation of the fan.

22

23 40. The fuel cell power system according to claim 39 wherein
24 the control system comprises a plurality of distributed controllers.

1 41. The fuel cell power system according to claim 39 wherein
2 the at least one fuel cell comprises a plurality of polymer electrolyte
3 membrane fuel cells.

4 5 42. The fuel cell power system according to claim 39 wherein
6 the at least one fuel cell comprises a plurality of fuel cells.

7 8 43. The fuel cell power system according to claim 42 wherein
9 the fuel cells are configured to be individually selectively deactivated
10 and remaining ones of the fuel cells are configured to provide electricity
11 to the terminals with others of the fuel cells deactivated.

12 13 44. The fuel cell power system according to claim 39 further
14 comprising at least one sensor configured to at least one of monitor
15 current supplied to a load coupled with the terminals and monitor
16 voltage of the at least one fuel cell, and the control system is
17 configured to control a rate of air flow of the fan responsive to the
18 monitoring.

19 20 45. The fuel cell power system according to claim 39 wherein
21 the at least one fuel cell includes a cathode side and the fan and the
22 housing are configured to direct air into the cathode side of the at
23 least one fuel cell.

1 46. The fuel cell power system according to claim 39 further
2 comprising a plenum within the housing and configured to direct air
3 from the fan to the at least one fuel cell.

4

5 47. The fuel cell power system according to claim 46 wherein
6 the plenum is configured to direct air to a cathode side of the at least
7 one fuel cell.

8

9 48. The fuel cell power system according to claim 39 further
10 comprising an air flow device configured to operate responsive to
11 control from the control system to permit selective passage of air at
12 least one of into and out of the housing.

13

14 49. The fuel cell power system according to claim 39 further
15 comprising monitoring circuitry configured to monitor an air flow rate
16 of the fan and output a signal indicative of the air flow rate to the
17 control system.

18

19 50. The fuel cell power system according to claim 49 wherein
20 the control system is configured to control an air flow rate of the fan.

1 51. A fuel cell power system comprising:
2 a housing;
3 a plurality of terminals;
4 at least one fuel cell within the housing and electrically coupled
5 with the terminals and configured to convert chemical energy into
6 electricity;
7 a control system configured to at least one of control and monitor
8 an operation of the at least one fuel cell; and
9 an operator interface coupled with the control system to indicate
10 at least one operational status responsive to control from the control
11 system.

12

13 52. The fuel cell power system according to claim 51 wherein
14 the control system comprises a plurality of distributed controllers.

15

16 53. The fuel cell power system according to claim 51 wherein
17 the at least one fuel cell comprises a plurality of polymer electrolyte-
18 membrane fuel cells.

19

20 54. The fuel cell power system according to claim 51 wherein
21 the at least one fuel cell comprises a plurality of fuel cells.

1 55. The fuel cell power system according to claim 54 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5
6 56. The fuel cell power system according to claim 51 wherein
7 the operator interface is positioned for observation from the exterior of
8 the housing.

9
10 57. The fuel cell power system according to claim 51 wherein
11 the operator interface comprises a display configured to emit a human
12 perceptible signal.

13
14 58. The fuel cell power system according to claim 51 wherein
15 the operator interface comprises interface switches configured to receive
16 operator inputs.

17
18 59. A fuel cell power system comprising:
19 a plurality of terminals;
20 at least one fuel cell electrically coupled with the terminals and
21 configured to convert chemical energy into electricity;
22 a power supply configured to selectively supply electricity; and
23 a control system configured to monitor at least one operational
24 condition of the power supply.

1 60. The fuel cell power system according to claim 59 wherein
2 the control system comprises a plurality of distributed controllers.

3
4 61. The fuel cell power system according to claim 59 wherein
5 the at least one fuel cell comprises a plurality of polymer electrolyte
6 membrane fuel cells.

7
8 62. The fuel cell power system according to claim 59 wherein
9 the at least one fuel cell comprises a plurality of fuel cells.

10
11 63. The fuel cell power system according to claim 62 wherein
12 the fuel cells are configured to be individually selectively deactivated
13 and remaining ones of the fuel cells are configured to provide electricity
14 to the terminals with others of the fuel cells deactivated.

15
16 64. The fuel cell power system according to claim 59 wherein
17 the power supply supplies electricity to the control system.

18
19 65. The fuel cell power system according to claim 59 wherein
20 the power supply includes a battery.

21
22 66. The fuel cell power system according to claim 65 further
23 comprising charge circuitry configured to selectively charge the battery
24 responsive to control from the control system.

1 67. The fuel cell power system according to claim 59 further
2 comprising an operator interface and the control system is configured
3 to control the operator interface to indicate the at least one operational
4 condition.

5

6 68. A fuel cell power system comprising:
7 a plurality of terminals;
8 at least one fuel cell electrically coupled with the terminals and
9 configured to convert chemical energy into electricity;
10 a sensor configured to monitor at least one electrical condition of
11 the at least one fuel cell; and
12 a control system coupled with the sensor and configured to
13 monitor the sensor.

14

15 69. The fuel cell power system according to claim 68 wherein
16 the control system comprises a plurality of distributed controllers.

17

18 70. The fuel cell power system according to claim 68 wherein
19 the at least one fuel cell comprises a plurality of polymer electrolyte
20 membrane fuel cells.

21

22 71. The fuel cell power system according to claim 68 wherein
23 the at least one fuel cell comprises a plurality of fuel cells.

1 72. The fuel cell power system according to claim 71 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5

6 73. The fuel cell power system according to claim 68 further
7 comprising an operator interface and the control system is configured
8 to control the operator interface to indicate the at least one electrical
9 condition.

10

11 74. The fuel cell power system according to claim 68 further
12 comprising a fan configured to direct air to the at least one fuel cell
13 and the control system is configured to control the fan responsive to
14 the at least one electrical condition.

15

16 75. A fuel cell power system comprising:
17 a plurality of terminals;
18 a plurality of fuel cells electrically coupled with the terminals and
19 configured to convert chemical energy into electricity;
20 a main valve adapted to couple with a fuel source and configured
21 to selectively supply fuel to the fuel cells; and
22 a control system configured to control the main valve.

1 76. The fuel cell power system according to claim 75 wherein
2 the control system comprises a plurality of distributed controllers.

3
4 77. The fuel cell power system according to claim 75 wherein
5 the fuel cells comprise polymer electrolyte membrane fuel cells.

6
7 78. The fuel cell power system according to claim 75 wherein
8 the fuel cells are configured to be individually selectively deactivated
9 and remaining ones of the fuel cells are configured to provide electricity
10 to the terminals with others of the fuel cells deactivated.

11
12 79. The fuel cell power system according to claim 75 further
13 comprising a plurality of auxiliary valves configured to selectively supply
14 fuel to respective fuel cells.

1 80. A fuel cell power system comprising:
2 a housing;
3 a plurality of terminals;
4 at least one fuel cell within the housing and electrically coupled
5 with the terminals and configured to convert chemical energy into
6 electricity;
7 an air temperature control assembly configured to direct air within
8 the housing to the at least one fuel cell and comprising a modifying
9 element configured to condition the temperature of the air; and
10 a control system configured to control the modifying element.

11
12 81. The fuel cell power system according to claim 80 wherein
13 the control system comprises a plurality of distributed controllers.

14
15 82. The fuel cell power system according to claim 80 wherein
16 the at least one fuel cell comprises a plurality of polymer electrolyte
17 membrane fuel cells.

18
19 83. The fuel cell power system according to claim 80 wherein
20 the at least one fuel cell comprises a plurality of fuel cells.

1 84. The fuel cell power system according to claim 83 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5
6 85. The fuel cell power system according to claim 80 further
7 comprising a temperature sensor configured to monitor the temperature
8 of the directed air within the housing.

9
10 86. The fuel cell power system according to claim 85 wherein
11 the control system is configured to monitor the temperature of the
12 directed air from the temperature sensor and to control the modifying
13 element responsive to the monitoring of the temperature.

14
15 87. The fuel cell power system according to claim 80 wherein
16 the modifying element comprises a heater.

1 88. A fuel cell power system comprising:

2 a housing;

3 a plurality of terminals;

4 at least one fuel cell within the housing and electrically coupled

5 with the terminals and configured to convert chemical energy into

6 electricity;

7 a fuel delivery system configured to supply fuel to the at least

8 one fuel cell;

9 a fuel sensor positioned within the housing; and

10 a control system configured to monitor a detection of fuel within

11 the housing using the fuel detection sensor.

12

13 89. The fuel cell power system according to claim 88 wherein

14 the control system comprises a plurality of distributed controllers.

15

16 90. The fuel cell power system according to claim 88 wherein

17 the at least one fuel cell comprises a plurality of polymer electrolyte

18 membrane fuel cells.

19

20 91. The fuel cell power system according to claim 88 wherein

21 the at least one fuel cell comprises a plurality of fuel cells.

1 92. The fuel cell power system according to claim 91 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5

6 93. The fuel cell power system according to claim 88 further
7 comprising an operator interface and the control system is configured
8 to control the operator interface to indicate a detection of fuel.

9

10 94. The fuel cell power system according to claim 88 wherein
11 the fuel sensor comprises a hydrogen gas sensor.

12

13 95. The fuel cell power system according to claim 88 wherein
14 the at least one fuel cell comprises a plurality of fuel cells, and the
15 fuel delivery system comprises a plurality of valves configured supply
16 fuel to respective ones of the fuel cells.

17

18 96. The fuel cell power system according to claim 95 wherein
19 the control system is configured to selectively close the valves responsive
20 to a detection of fuel using the fuel sensor.

21

22 97. The fuel cell power system according to claim 88 further
23 comprising a heater configured to selectively impart heat flux to the
24 fuel sensor.

1 98. A fuel cell power system comprising:
2 a housing;
3 a plurality of terminals;
4 at least one fuel cell within the housing and electrically coupled
5 with the terminals and configured to convert chemical energy into
6 electricity;
7 a temperature sensor within the housing; and
8 a control system coupled with the temperature sensor and
9 configured to monitor the temperature in the housing using the
10 temperature sensor.

11
12 99. The fuel cell power system according to claim 98 wherein
13 the control system comprises a plurality of distributed controllers.

14
15 100. The fuel cell power system according to claim 98 wherein
16 the at least one fuel cell comprises a plurality of polymer electrolyte
17 membrane fuel cells.

18
19 101. The fuel cell power system according to claim 98 wherein
20 the at least one fuel cell comprises a plurality of fuel cells.

1 102. The fuel cell power system according to claim 101 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5

6 103. The fuel cell power system according to claim 98 further
7 comprising an air temperature control assembly configured to at least
8 one of increase and decrease the temperature in the housing.

9

10 104. The fuel cell power system according to claim 103 wherein
11 the control system is configured to control the air temperature control
12 assembly.

13

14 105. The fuel cell power system according to claim 103 wherein
15 the control system is configured to control the air temperature control
16 assembly to maintain the temperature in the housing within a predefined
17 range.

18

19 106. The fuel cell power system according to claim 103 wherein
20 the control system is configured to control the air temperature control
21 assembly to maintain the temperature in the housing within a predefined
22 range of approximately 25 °Celsius to 80 °Celsius.

1 107. The fuel cell power system according to claim 103 wherein
2 the air temperature control assembly comprises:

3 a fan configured to circulate air within the housing; and
4 an air flow device configured to permit selective passage of air
5 at least one of into and out of the housing.

6

7 108. The fuel cell power system according to claim 107 wherein
8 the control system is configured to control the fan and the air flow
9 device.

10

11 109. The fuel cell power system according to claim 98 further
12 comprising a temperature sensor configured to monitor a temperature
13 exterior of the housing.

14

15 110. A fuel cell power system comprising:
16 a plurality of terminals;
17 at least one fuel cell within the housing and electrically coupled
18 with the terminals and configured to convert chemical energy into
19 electricity;
20 at least one switching device configured to selectively shunt the
21 at least one fuel cell; and
22 a control system configured to control the at least one switching
23 device.

1 111. The fuel cell power system according to claim 110 wherein
2 the control system comprises a plurality of distributed controllers.

3

4 112. The fuel cell power system according to claim 110 wherein
5 the at least one fuel cell comprises a plurality of polymer electrolyte
6 membrane fuel cells.

7

8 113. The fuel cell power system according to claim 110 wherein
9 the at least one fuel cell comprises a plurality of fuel cells.

10

11 114. The fuel cell power system according to claim 113 wherein
12 the fuel cells are configured to be individually selectively deactivated
13 and remaining ones of the fuel cells are configured to provide electricity
14 to the terminals with others of the fuel cells deactivated.

15

16 115. The fuel cell power system according to claim 110 wherein
17 the control system is configured to shunt the at least one fuel cell for
18 a variable period of time.

19

20 116. The fuel cell power system according to claim 110 wherein
21 the at least one fuel cell comprises plural fuel cells and the at least
22 one switching device comprises plural switching devices.

1 117. The fuel cell power system according to claim 116 wherein
2 the control system is configured to sequentially shunt the fuel cells using
3 the respective switching devices.

4
5 118. The fuel cell power system according to claim 116 wherein
6 the control system is configured to shunt individual ones of the fuel
7 cells using the respective switching devices.

8
9 119. The fuel cell power system according to claim 116 wherein
10 the control system is configured to shunt the individual ones of the fuel
11 cells according to a specified order.

12
13 120. The fuel cell power system according to claim 116 further
14 comprising a plurality of valves individually configured to selectively
15 supply fuel to respective fuel cells, and wherein the control system is
16 configured to control the valves.

17
18 121. The fuel cell power system according to claim 120 wherein
19 the control system is configured to cease supply of fuel to shunted fuel
20 cells using respective ones of the valves.

21
22 122. The fuel cell power system according to claim 116 wherein
23 the switching devices comprise MOSFET switching devices.

1 123. A fuel cell power system comprising:
2 a housing;
3 a plurality of terminals;
4 at least one fuel cell within the housing and electrically coupled
5 with the terminals and configured to convert chemical energy into
6 electricity;

7 a switching device coupled intermediate the at least one fuel cell
8 and one of the terminals; and

9 a control system coupled with the switching device and configured
10 to control the switching device to selectively couple the terminal with
11 the at least one fuel cell.

12
13 124. The fuel cell power system according to claim 123 wherein
14 the control system comprises a plurality of distributed controllers.

15
16 125. The fuel cell power system according to claim 123 wherein
17 the at least one fuel cell comprises a plurality of polymer electrolyte
18 membrane fuel cells.

19
20 126. The fuel cell power system according to claim 123 wherein
21 the at least one fuel cell comprises a plurality of fuel cells.

1 127. The fuel cell power system according to claim 126 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5

6 128. The fuel cell power system according to claim 123 wherein
7 the switching device comprises at least one MOSFET switching device.

8

9 129. The fuel cell power system according to claim 123 further
10 comprising a temperature sensor positioned within the housing, and the
11 control system is configured to monitor the temperature within the
12 housing and to couple the terminal with the at least one fuel cell using
13 the switching device responsive to the temperature being within a
14 predefined range.

15

16 130. A method of controlling a fuel cell power system comprising:
17 providing a plurality of fuel cells individually configured to convert
18 chemical energy into electricity;
19 electrically coupling the plurality of fuel cells;
20 providing a first terminal coupled with the fuel cells;
21 providing a second terminal coupled with the fuel cells; and
22 coupling a digital control system with the fuel cells to at least
23 one of monitor and control an operation of the fuel cells.

1 131. The method according to claim 130 further comprising
2 monitoring the operation of the fuel cells.

3
4 132. The method according to claim 130 further comprising
5 controlling the operation of the fuel cells.

6
7 133. The method according to claim 130 wherein the coupling the
8 control system comprises coupling a plurality of distributed controllers.

9
10 134. The method according to claim 130 wherein the providing
11 the fuel cells comprises providing polymer electrolyte membrane fuel
12 cells.

13
14 135. The method according to claim 134 further comprising
15 deactivating at least one of the fuel cells.

16
17 136. The method according to claim 135 wherein the deactivating
18 comprises physically removing.

19
20 137. The method according to claim 135 wherein the deactivating
21 comprises electrically bypassing.

1 138. The method according to claim 135 further comprising
2 providing electricity to a load coupled with the terminals with the at
3 least one fuel cell deactivated.

4

5 139. The method according to claim 130 further comprising
6 selectively shunting at least one of the fuel cells.

7

8 140. The method according to claim 130 further comprising:
9 monitoring at least one electrical characteristic of the fuel cells;
10 and

11 shunting at least one of the fuel cells responsive to the
12 monitoring.

13

14 141. The method according to claim 130 further comprising
15 maintaining an air temperature about the fuel cells in a predefined
16 range.

17

18 142. The method according to claim 130 further comprising
19 maintaining an air temperature about the fuel cells in a predefined
20 range of approximately 25 °Celsius to 80 °Celsius.

21

22 143. The method according to claim 130 further comprising
23 directing air to the fuel cells using a fan.

1 144. The method according to claim 143 further comprising:
2 monitoring a load coupled with the terminals; and
3 controlling the fan responsive to the monitoring using the control
4 system.

5
6 145. The method according to claim 130 further comprising:
7 supplying fuel to the fuel cells using a plurality of auxiliary
8 valves; and
9 controlling the auxiliary valves using the control system.

10
11 146. The method according to claim 145 further comprising:
12 supplying fuel to the auxiliary valves using a main valve; and
13 controlling the main valve using the control system.

14
15 147. The method according to claim 130 further comprising:
16 communicating with a remote device using a communication port;
17 and
18 controlling the communicating using the control system.

19
20 148. The method according to claim 130 further comprising:
21 switching a connection intermediate one of the terminals and the
22 fuel cells; and
23 controlling the switching using the control system.

1 149. The method according to claim 130 further comprising:
2 monitoring for the presence of fuel within a housing about the
3 fuel cells; and
4 implementing a shut down operation responsive to the monitoring
5 using the control system.

6

7 150. The method according to claim 149 wherein the
8 implementing deactivates one or more of the fuel cells.

9

10 151. The method according to claim 149 wherein the
11 implementing deactivates all of the fuel cells.

12

13 152. A method of controlling a fuel cell power system comprising:
14 providing at least one fuel cell configured to convert chemical
15 energy into electricity;
16 providing a first terminal coupled with the at least one fuel cell;
17 providing a second terminal coupled with the at least one fuel
18 cell;
19 supplying fuel to the at least one fuel cell; and
20 controlling the supplying using a control system.

21

22 153. The method according to claim 152 wherein the controlling
23 comprises controlling using the control system comprising a plurality of
24 distributed controllers.

1 154. The method according to claim 152 wherein the providing
2 the at least one fuel cell comprises providing the at least one fuel cell
3 having a plurality of polymer electrolyte membrane fuel cells.

4

5 155. The method according to claim 152 wherein the providing
6 the at least one fuel cell comprises providing a plurality of fuel cells.

7

8 156. The method according to claim 155 further comprising
9 deactivating at least one of the fuel cells.

10

11 157. The method according to claim 156 further comprising
12 providing electricity to a load coupled with the terminals with the at
13 least one fuel cell deactivated.

14

15 158. The method according to claim 152 further comprising
16 monitoring at least one electrical characteristic of the at least one fuel
17 cell, and the controlling is responsive to the monitoring.

1 159. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 selectively exhausting a connection coupled with the at least one
8 fuel cell; and
9 controlling the exhausting using a control system.

10
11 160. The method according to claim 159 wherein the controlling
12 comprises controlling using the control system comprising a plurality of
13 distributed controllers.

14
15 161. The method according to claim 159 wherein the providing
16 the at least one fuel cell comprises providing the at least one fuel cell
17 having a plurality of polymer electrolyte membrane fuel cells.

18
19 162. The method according to claim 159 wherein the providing
20 the at least one fuel cell comprises providing a plurality of fuel cells.

21
22 163. The method according to claim 162 further comprising
23 deactivating at least one of the fuel cells.

1 164. The method according to claim 163 further comprising
2 providing electricity to a load coupled with the terminals with the at
3 least one fuel cell deactivated.

4

5 165. The method according to claim 159 wherein the selectively
6 exhausting comprises periodically exhausting responsive to control of the
7 control system.

8

9 166. The method according to claim 159 wherein the exhausting
10 comprises exhausting using a bleed valve.

11

12 167. The method according to claim 159 wherein the exhausting
13 comprises exhausting from an anode of the at least one fuel cell.

14

15 168. A method of controlling a fuel cell power system comprising:
16 providing at least one fuel cell configured to convert chemical
17 energy into electricity;
18 providing a first terminal coupled with the at least one fuel cell;
19 providing a second terminal coupled with the at least one fuel
20 cell;
21 directing air to the at least one fuel cell; and
22 controlling the directing using a control system.

1 169. The method according to claim 168 wherein the controlling
2 comprises controlling using the control system comprising a plurality of
3 distributed controllers.

4

5 170. The method according to claim 168 wherein the providing
6 the at least one fuel cell comprises providing the at least one fuel cell
7 having a plurality of polymer electrolyte membrane fuel cells.

8

9 171. The method according to claim 168 wherein the providing
10 the at least one fuel cell comprises providing a plurality of fuel cells.

11

12 172. The method according to claim 171 further comprising
13 deactivating at least one of the fuel cells.

14

15 173. The method according to claim 172 further comprising
16 providing electricity to a load coupled with the terminals with the at
17 least one fuel cell deactivated.

18

19 174. The method according to claim 168 further comprising
20 providing electricity to a load coupled with the terminals, and the
21 controlling is responsive to the monitoring.

1 175. The method according to claim 168 further comprising
2 monitoring at least one of voltage of the at least one fuel cell and
3 current passing through the at least one fuel cell, and the controlling
4 is responsive to the monitoring.

5
6 176. The method according to claim 168 wherein the directing
7 comprises directing air into a cathode side of the at least one fuel cell.

8
9 177. The method according to claim 176 wherein the directing
10 comprises directing using a fan, and the controlling comprises controlling
11 an air flow rate of the fan.

12
13 178. The method according to claim 168 further comprising
14 introducing exterior air into a housing about the at least one fuel cell.

15
16 179. The method according to claim 168 further comprising
17 monitoring the temperature of the air.

18
19 180. The method according to claim 179 further comprising
20 controlling a modifying element using the control system to control the
21 temperature of the air responsive to the monitoring.

1 181. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 indicating at least one operational status of the fuel cell power
8 system using an operator interface; and
9 controlling the indicating using a control system.

10
11 182. The method according to claim 181 wherein the controlling
12 comprises controlling using the control system comprising a plurality of
13 distributed controllers.

14
15 183. The method according to claim 181 wherein the providing
16 the at least one fuel cell comprises providing the at least one fuel cell
17 having a plurality of polymer electrolyte membrane fuel cells.

18
19 184. The method according to claim 181 wherein the providing
20 the at least one fuel cell comprises providing a plurality of fuel cells.

21
22 185. The method according to claim 184 further comprising
23 deactivating at least one of the fuel cells.

1 186. The method according to claim 185 further comprising
2 providing electricity to a load coupled with the terminals with the at
3 least one fuel cell deactivated.

4

5 187. The method according to claim 181 wherein the indicating
6 comprises emitting a human perceptible signal.

7

8 188. The method according to claim 181 wherein the indicating
9 comprises indicating using a display.

10

11 189. The method according to claim 181 further comprising
12 forwarding the at least one operational status to a remote device.

13

14 190. The method according to claim 181 further comprising
15 receiving operator inputs using the operator interface.

1 191. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 supplying electricity using a power supply; and
8 monitoring at least one electrical condition of the power supply
9 using a control system.

10
11 192. The method according to claim 191 wherein the controlling
12 comprises controlling using the control system comprising a plurality of
13 distributed controllers.

14
15 193. The method according to claim 191 wherein the providing
16 the at least one fuel cell comprises providing the fuel cell having a
17 plurality of polymer electrolyte membrane fuel cells.

18
19 194. The method according to claim 191 wherein the providing
20 the at least one fuel cell comprises providing a plurality of fuel cells.

21
22 195. The method according to claim 194 further comprising
23 deactivating at least one of the fuel cells.

1 196. The method according to claim 195 further comprising
2 providing electricity to a load coupled with the terminals with the at
3 least one fuel cell deactivated.

4

5 197. The method according to claim 191 wherein the supplying
6 comprises supplying electricity to the control system.

7

8 198. The method according to claim 191 wherein the supplying
9 comprises supplying power using the power supply comprising a battery.

10

11 199. The method according to claim 198 further comprising:
12 charging the battery; and
13 controlling the charging using the control system.

14

15 200. A method of controlling a fuel cell power system comprising:
16 providing at least one fuel cell configured to convert chemical
17 energy into electricity;
18 providing a first terminal coupled with the at least one fuel cell;
19 providing a second terminal coupled with the at least one fuel
20 cell; and
21 monitoring an electrical condition of the at least one fuel cell
22 using a control system.

1 201. The method according to claim 200 wherein the controlling
2 comprises controlling using the control system comprising a plurality of
3 distributed controllers.

4

5 202. The method according to claim 200 wherein the providing
6 the at least one fuel cell comprises providing the fuel cell having a
7 plurality of polymer electrolyte membrane fuel cells.

8

9 203. The method according to claim 200 wherein the providing
10 the at least one fuel cell comprises providing a plurality of fuel cells.

11

12 204. The method according to claim 203 further comprising
13 deactivating at least one of the fuel cells.

14

15 205. The method according to claim 204 further comprising
16 providing electricity to a load coupled with the terminals with the at
17 least one fuel cell deactivated.

18

19 206. The method according to claim 200 further comprising
20 indicating the electrical condition using an operator interface.

1 207. The method according to claim 200 further comprising:
2 directing air to the at least one fuel cell; and
3 controlling the directing using the control system responsive to the
4 monitoring.

5

6 208. The method according to claim 200 further comprising
7 shunting the at least one fuel cell after the monitoring.

8

9 209. A method of controlling a fuel cell power system comprising:
10 providing a plurality of fuel cells individually configured to convert
11 chemical energy into electricity;
12 providing a first terminal coupled with the fuel cells;
13 providing a second terminal coupled with the fuel cells;
14 supplying fuel to the fuel cells; and
15 controlling the supplying using a control system.

16

17 210. The method according to claim 209 wherein the controlling
18 comprises controlling using the control system comprising a plurality of
19 distributed controllers.

20

21 211. The method according to claim 209 wherein the providing
22 the fuel cells comprises providing a plurality of polymer electrolyte
23 membrane fuel cells.

1 212. The method according to claim 209 further comprising
2 deactivating at least one of the fuel cells.

3
4 213. The method according to claim 212 further comprising
5 providing electricity to a load coupled with the terminals with the at
6 least one fuel cell deactivated.

7
8 214. The method according to claim 209 wherein the supplying
9 comprises supplying using a main valve.

10
11 215. The method according to claim 209 wherein the supplying
12 comprises:

13 supplying using a main valve; and

14 supplying using a plurality of auxiliary valves.

15
16 216. The method according to claim 215 wherein the controlling
17 comprises controlling the main valve and the auxiliary valves using the
18 control system.

1 217. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 supplying fuel to the at least one fuel cell; and
8 monitoring for the presence of fuel within a housing about the
9 at least one fuel cell using a control system.

10
11 218. The method according to claim 217 wherein the controlling
12 comprises controlling using the control system comprising a plurality of
13 distributed controllers.

14
15 219. The method according to claim 217 wherein the providing
16 the at least one fuel cell comprises providing the fuel cell having a
17 plurality of polymer electrolyte membrane fuel cells.

18
19 220. The method according to claim 217 wherein the providing
20 the at least one fuel cell comprises providing a plurality of fuel cells.

21
22 221. The method according to claim 220 further comprising
23 deactivating at least one of the fuel cells.

1 222. The method according to claim 221 further comprising
2 providing electricity to a load coupled with the terminals with the at
3 least one fuel cell deactivated.

4

5 223. The method according to claim 217 further comprising:
6 coupling an operator interface with the control system; and
7 controlling the operator interface using the control system to
8 indicate the presence of fuel within the housing.

9

10 224. The method according to claim 217 further comprising:
11 selectively ceasing the supplying responsive to the monitoring; and
12 controlling the ceasing using the control system.

13

14 225. The method according to claim 217 wherein the monitoring
15 comprises monitoring using a fuel sensor.

16

17 226. The method according to claim 225 further comprising
18 heating the fuel sensor.

1 227. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell; and
7 monitoring a temperature within a housing about the at least one
8 fuel cell using a control system.

9

10 228. The method according to claim 227 wherein the controlling
11 comprises controlling using the control system comprising a plurality of
12 distributed controllers.

13

14 229. The method according to claim 227 wherein the providing
15 the at least one fuel cell comprises providing the fuel cell having a
16 plurality of polymer electrolyte membrane fuel cells.

17

18 230. The method according to claim 227 wherein the providing
19 the at least one fuel cell comprises providing a plurality of fuel cells.

20

21 231. The method according to claim 230 further comprising
22 deactivating at least one of the fuel cells.

1 232. The method according to claim 231 further comprising
2 providing electricity to a load coupled with the terminals with the at
3 least one fuel cell deactivated.

4

5 233. The method according to claim 227 further comprising
6 selectively one of increasing and decreasing the temperature in the
7 housing using an air temperature control assembly.

8

9 234. The method according to claim 233 further comprising
10 controlling the air temperature control assembly using the control system
11 and responsive to the monitoring.

12

13 235. The method according to claim 234 wherein the controlling
14 comprises controlling to maintain the temperature in the housing within
15 a predefined range.

16

17 236. The method according to claim 234 wherein the controlling
18 comprises controlling to maintain the temperature in the housing within
19 a predefined range of approximately 25 °Celsius and 80 °Celsius.

20

21 237. The method according to claim 227 further comprising:
22 directing air to the at least one fuel cell; and
23 controlling the directing using the control system and responsive
24 to the monitoring.

1 238. The method according to claim 227 further comprising:
2 inputting exterior air into the housing; and
3 controlling the inputting using the control system and responsive
4 to the monitoring.

5

6 239. The method according to claim 227 further comprising
7 monitoring a temperature exterior of the housing.

8

9 240. The method according to claim 227 wherein the monitoring
10 comprises monitoring using a temperature sensor.

11

12 241. A method of controlling a fuel cell power system comprising:
13 providing at least one fuel cell configured to convert chemical
14 energy into electricity;
15 providing a first terminal coupled with the at least one fuel cell;
16 providing a second terminal coupled with the at least one fuel
17 cell;
18 shunting the at least one fuel cell; and
19 controlling the shunting using a control system.

20

21 242. The method according to claim 241 wherein the controlling
22 comprises controlling using the control system comprising a plurality of
23 distributed controllers.

1 243. The method according to claim 241 wherein the providing
2 the at least one fuel cell comprises providing the fuel cell having a
3 plurality of polymer electrolyte membrane fuel cells.

4
5 244. The method according to claim 241 further comprising
6 varying a period of time of the shunting using the control system.

7
8 245. The method according to claim 241 wherein the providing
9 the at least one fuel cell comprises providing a plurality of fuel cells.

10
11 246. The method according to claim 245 further comprising
12 deactivating at least one of the fuel cells.

13
14 247. The method according to claim 246 further comprising
15 providing electricity to a load coupled with the terminals with the at
16 least one fuel cell deactivated.

17
18 248. The method according to claim 245 further comprising
19 sequentially shunting the fuel cells.

20
21 249. The method according to claim 245 further comprising
22 shunting individual ones of the fuel cells.

1 250. The method according to claim 245 further comprising
2 shunting the fuel cells according to a specified order.

3
4 251. The method according to claim 245 further comprising:
5 supplying fuel to the fuel cells; and
6 ceasing the supplying to shunted fuel cells.

7
8 252. A method of controlling a fuel cell power system comprising:
9 providing at least one fuel cell configured to convert chemical
10 energy into electricity;
11 providing a first terminal coupled with the at least one fuel cell;
12 providing a second terminal coupled with the at least one fuel
13 cell;
14 switching a connection immediate one of the terminals and the at
15 least one fuel cell; and
16 controlling the switching using a control system.

17
18 253. The method according to claim 252 wherein the controlling
19 comprises controlling using the control system comprising a plurality of
20 distributed controllers.

21
22 254. The method according to claim 252 wherein the providing
23 the at least one fuel cell comprises providing the fuel cell having a
24 plurality of polymer electrolyte membrane fuel cells.

1 255. The method according to claim 252 wherein the providing
2 the at least one fuel cell comprises providing a plurality of fuel cells.
3

4 256. The method according to claim 255 further comprising
5 deactivating at least one of the fuel cells.
6

7 257. The method according to claim 256 further comprising
8 providing electricity to a load coupled with the terminals with the at
9 least one fuel cell deactivated.
10

11 258. The method according to claim 252 further comprising
12 monitoring a temperature within a housing about the at least one fuel
13 cell and the controlling is responsive to the monitoring.
14

15 259. A method of operating a fuel cell power system comprising:
16 initiating a start-up procedure;
17 monitoring the temperature within a housing containing at least
18 one fuel cell;
19 selectively adjusting the temperature within the housing using a
20 modifying element responsive to the monitoring; and
21 coupling a power bus with a terminal responsive to the
22 monitoring.
23
24

1 260. The method according to claim 259 further comprising
2 monitoring for the presence of fuel.

3
4 261. The method according to claim 259 further comprising:
5 shunting the at least one fuel cell according to a duty cycle; and
6 selectively setting the duty cycle to maximum.

7
8 262. The method according to claim 259 wherein the adjusting
9 comprises heating using the modifying element to increase the
10 temperature.

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